



Anaerobic Digester Optimization with Bio-Organic Catalyst®



VILLAGE OF RIDGEWOOD
POLLUTION CONTROL DEPARTMENT

NYWEA 81st Annual Meeting February 3, 2009
One Year Study November '07 - November '08



Municipal Anaerobic Digester Optimization Program Index

- **Overview Ridgewood Water Pollution Control Facility (WPCF)**
- **Description of Operating Baselines:**
 - **Biogas Production**
 - **Sludge Volumes**
 - **Secondary Aeration Energy Usage**
- **Anaerobic Digestion Optimization with BOC**
- **Summary & Potential Economic Values**

Water Pollution Control Facility Ridgewood, N.J.

The Village of Ridgewood located in Bergen County, New Jersey, is the fourth largest community in Bergen County, with a population of 25,500 and land area of 5.79 square miles.

The Department of Public Works - Division of Water Pollution Control, operates the wastewater treatment plant (WPCF) and the sewage collection system.

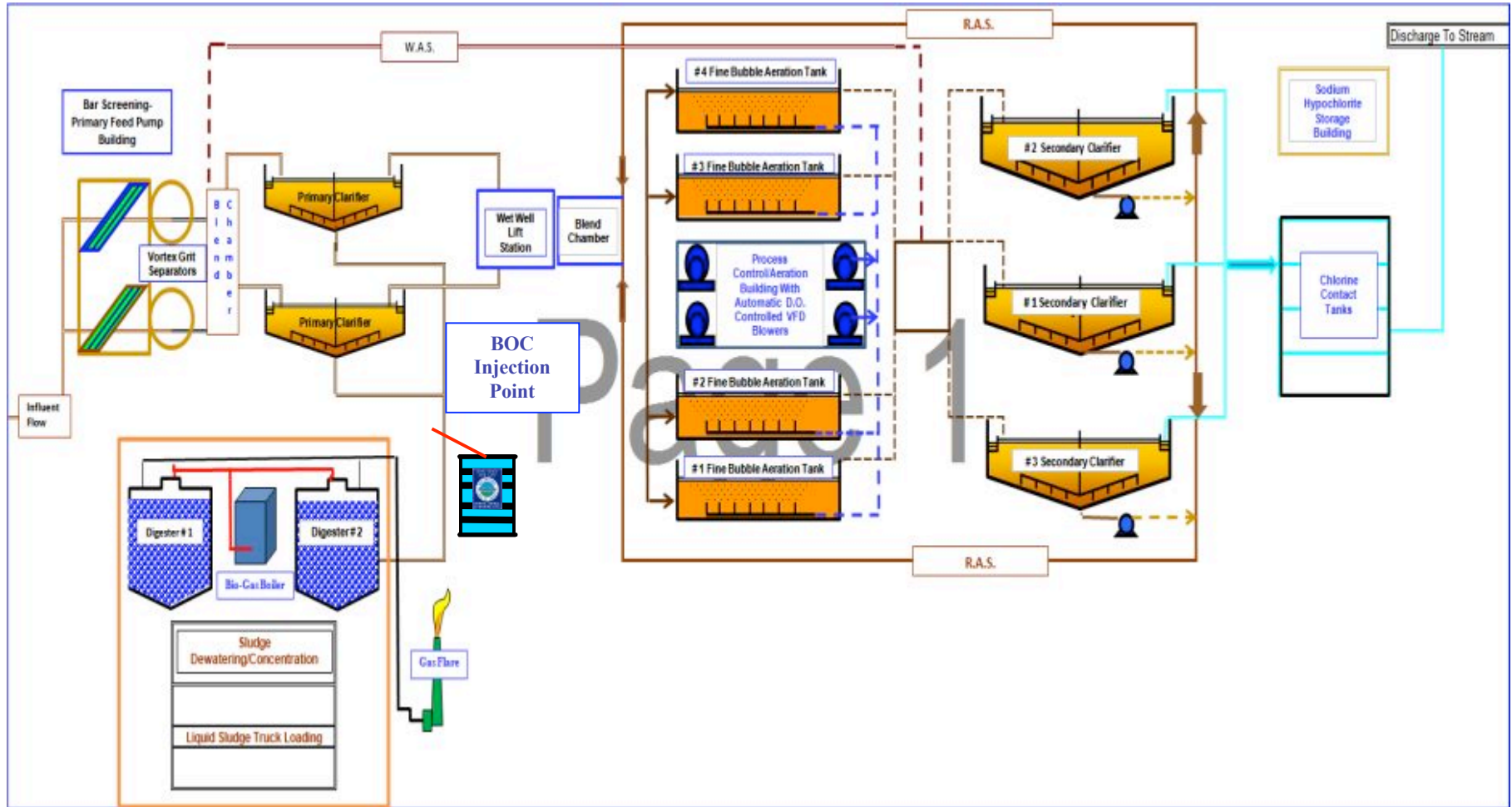
The Ridgewood, NJ WPCF receives an average daily flow of 2.6 - 3.0 MGD.

The sewage collection system is 92 miles in length, a combination of gravity and force mains. The lines range from 8 inches to 30 inches in diameter.

There are 6 pumping stations which pump influent flow into the WPCF.

The WPCF is operated as an activated sludge plant: with primary clarifiers, secondary aeration, secondary clarifiers, and anaerobic digester. It concentrates digested sludge prior to sending it off-site for incineration.

Ridgewood NJ WPCF Layout and BOC Injection Point



Ridgewood NJ WPCF Anaerobic Digestion (AD) System

- The anaerobic digester functions in the mesophilic temperature range of 38.3° C/101°F.
- The anaerobic digester has a volume of 500,000 gallons/1893 cubic meters.
- The baseline average primary feed sludge loading was 27,500 gallons /104 cubic meters daily.
- The average HRT was 18.3 days.
- Biomethane generated is burned in a boiler to heat incoming primary feed sludge and to maintain the digester temperature. Excess biomethane is flared off.
- The clear liquid "supernatant" is withdrawn from the top of a 500,000 gallons/1893 cubic meter holding tank and recycled to the influent wet

Analytical Values of Anaerobic Digestion during BOC Optimization Program

Anaerobic Digestion analytical values:

Biomethane yields;

- Per cubic feet (CuFt³)
 - Per lb. of T.S. & T.V.S.
 - Per gal. of primary feed sludge.
 - Per 100 gals. of influent flow.
-
- Reduction/replacement in the consumption of natural gas in boiler heating anaerobic digesters (AD).
 - Reduction of digester sludge volumes and weight.
 - Reduction of aeration energy consumption in secondary aeration channels, i.e. energy used (kWh/Lb of CBOD₅).
 - Reduction of volatile organics for odor reduction in digester dewatering operation and dewatered sludge.

Operating Baseline Values & BOC Injection Period

Comparison Of Baseline Values & BOC Injection Period

| Comparison Of Baseline vs. Optimum BOC Injection Period | | | Baseline Period Aver. 03/07-7/07 | BOC Optimum Injection Period Aver.-3/08-7/08 | % Increase (Decrease) Over Baseline | Notes |
|---|-------------------------|--|----------------------------------|--|-------------------------------------|------------------|
| Influent Flow & Load | FLOW | Influent Flow-MGD | 3.45 | 2.45 | -28.9% | Decreased |
| | | Influent Flow-100 GPD | 34,510 | 24,559 | -28.9% | Decreased |
| | | Influent Flow-m ³ /day | 13,063 | 9,285 | -28.9% | Decreased |
| | TEMPERATURE | TEMP.Daily Aver.-°C | 19.1 | 17.9 | -6.5% | Decreased |
| | CBOD₅ | Influent CBOD5-mg/L | 194.9 | 202.0 | 3.6% | Increased |
| | T.S.S | T.S.S.-mg/L | 232.3 | 266.3 | 14.7% | Increased |
| | AMMONIA-N | AMMONIA-N-mg/L | 10.9 | 18.5 | 70.9% | Increased |
| | TOTAL P | TOTAL P-mg/L | 4.89 | 6.3 | 28.8% | Increased |
| | GRIT REMOVAL | Cubic Feet Per Month | 259 | 367 | | |
| PRIMARY EFFLUENT | CBOD₅ | Primary Effluent CBOD ₅ -mg/L | 83.1 | 84.8 | 2.1% | Increased |
| | T.S.S | T.S.S.-mg/L | 99.6 | 102.0 | 2.5% | Increased |
| | CBOD₅ | % Removal Of CBOD5 (Infl. vs.. Primary Effluent) | 56.2 | 57.9 | 2.9% | Improved |
| | T.S.S | % Removal Of T.S.S.- (Infl. vs.. Primary Effluent) | 56.3 | 61.0 | 8.3% | Improved |

Plant Effluent-Comparison Of Baseline Values & BOC Injection Period

| Comparison Of Baseline vs. Optimum BOC Injection Period | | | Baseline Period Aver. 03/07-7/07 | BOC Optimum Injection Period Aver.-3/08-7/08 | % Increase (Decrease) Over Baseline | Notes |
|---|-------------------------|--|----------------------------------|--|-------------------------------------|----------|
| PLANT EFFLUENT | CBOD₅ | Plant Effluent CBOD ₅ -mg/L | 7.0 | 6.3 | | |
| | | CBOD ₅ Removal % (Influent vs.. Effluent) | 96.1% | 96.8% | 0.7% | Improved |
| | T.S.S | T.S.S.-mg/L | 6.4 | 6.9 | | |
| | | T.S.S.-Removal % (Influent vs.. Effluent) | 97.3% | 97.4% | 0.1% | Improved |
| | D.O. | D.O.-mg/L | 6.69 | 6.90 | 3.1% | Improved |
| | AMMONIA-N | AMMONIA-N-mg/L | 1.21 | 1.07 | | |
| | | AMMONIA-N-Removal % (Influent vs.. Effluent) | 88.9 | 94.4 | 6.3% | Improved |
| | TOTAL P | TOTAL P-mg/L | 2.9 | 3.5 | | |
| | | TOTAL P-Removal % (Influent vs.. Effluent) | 40.6 | 42.7 | 4.7% | Improved |

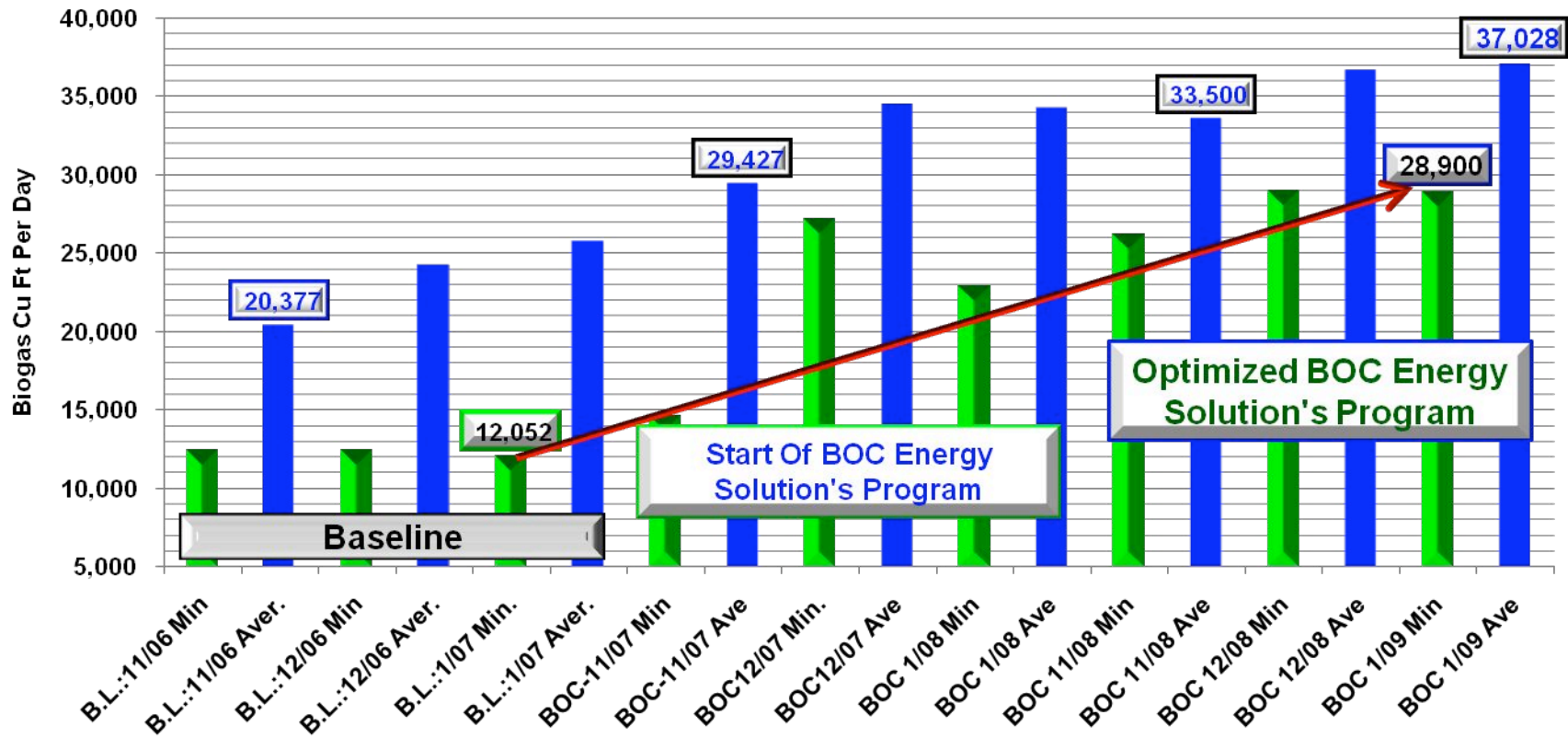
Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

| Comparison Of Baseline vs. Optimum BOC Injection Period | Baseline Period Aver. 03/07-7/07 | BOC Optimum Injection Period Aver.-3/08-7/08 | % Increase (Decrease) Over Baseline | Notes |
|---|-------------------------------------|---|--|------------------|
| Daily Ave- CuFt ³ Of Bio Gas Produced | 21,518 | 34,958 | 62% | Increased |
| HRT-Days | 18.4 | 16.5 | 11.5% | Decreased |
| CuFt ³ of Biogas /Day Of HRT | 1,167 | 2,328 | 99.5% | Increased |
| % TS Reduction-Aver. (Max) | 17.9% | 27.2% (65%) | 52% | Increased |
| % TVS Reduction-Aver. (Max) | 49.6% | 54.0% (75%) | 8.9% | Increased |
| T.S. Yield : CuFt ³ of Biogas per Lb removed | 8.5 | 15.9 | 87.1% | Increased |
| T.V.S. Yield : CuFt ³ of Biogas per Lb removed | 9.0 | 14.3 | 58.9% | Increased |
| Yield Of Biogas- CuFt ³ / 100 Gal Of Influent Flow | .68 | 1.39 | 105% | Increased |

Minimum & Daily Average Biogas Production (CuFt³)

Increased & More Consistent Biogas Yields-Daily Minimum
& Total Biogas CuFt³ Of Production

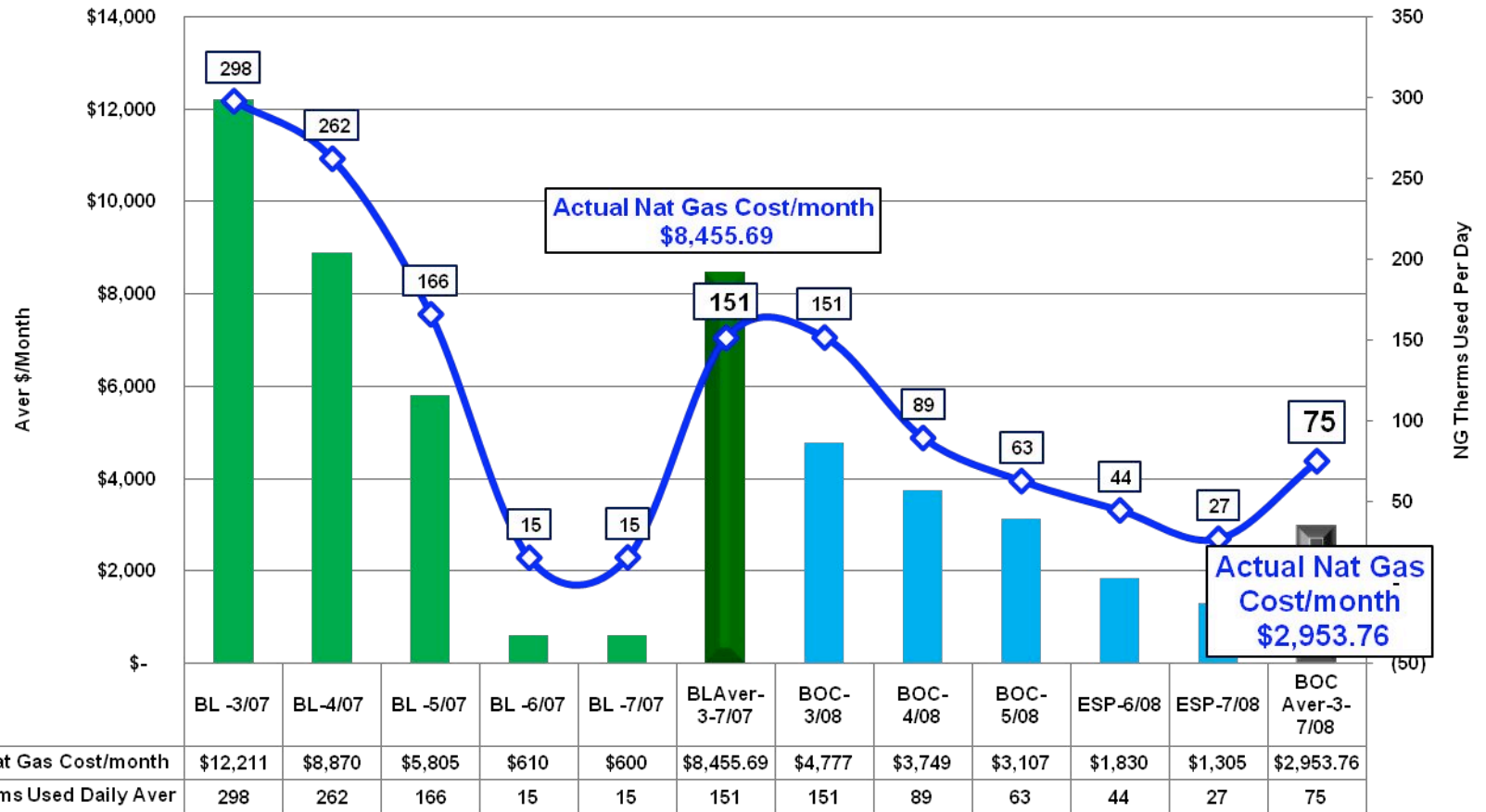


Biogas-Comparison Of Baseline Values & BOC Injection Period

| Comparison Of Baseline vs. Optimum BOC Injection Period | Baseline Period Aver. 3/07-7/07 | BOC Optimum Injection Period Aver.-3/08-7/08 | % Increase (Decrease) Over Baseline | Notes |
|--|---------------------------------|--|-------------------------------------|-----------|
| Gallons of primary sludge to AD-daily average | 27,172 | 32,433 | 19% | Increased |
| Daily average-cu ft ³ of biogas produced | 21,518 | 34,958 | 62% | Increased |
| Cu Ft ³ Of bio-gas required heat primary feed sludge to aver. AD Temp. @ 600 BTU's / Cu Ft ³ | 16,200 | 15,676 | -3% | Decreased |
| Daily Ave-BTU's of biogas produced | 10,759,238 | 20,975,012 | 95% | Increased |
| Daily BTU's required heat primary feed sludge to aver. AD temp. | 8,100,070 | 9,405,563 | 16% | Increased |
| Excess biogas BTU's produced | 2,659,168 | 11,569,450 | 335% | Increased |
| Excess daily Cu Ft ³ of biogas produced to heat primary feed sludge to correct aver. A.D Temp. | 5,318 | 19,282 | 263% | Increased |

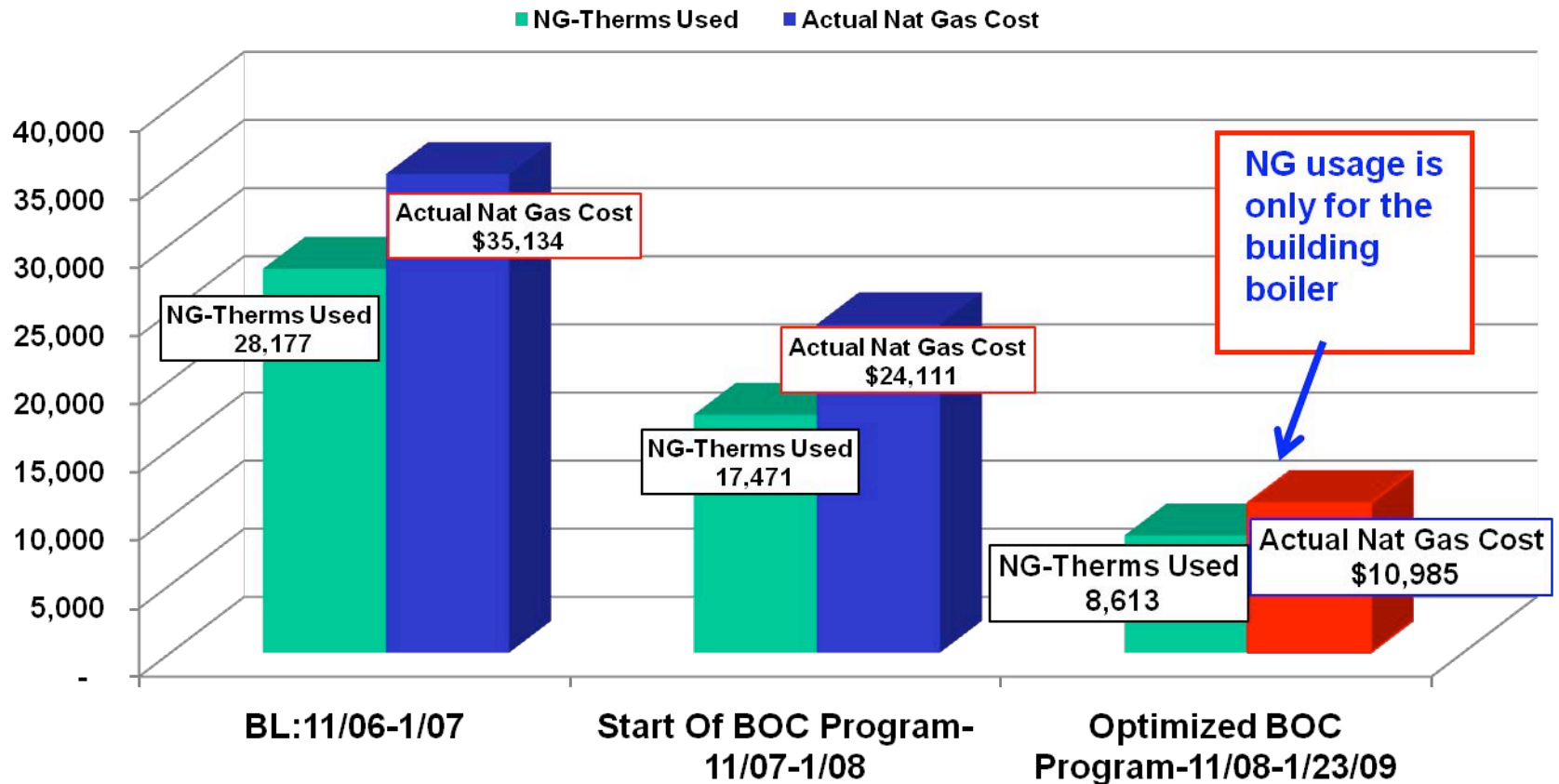
Reduction Of NG Cost/ Month & Therm Usage with BOC Optimization

Comparison Of Aver. NG Cost/Month Vs Reduction Of NG Therms



Reduction In Total Cost and NG Therm Usage

Reduction In Total Cost and NG Therm Usage



Comparison of Baseline Values & Lower NG Usage and Cost

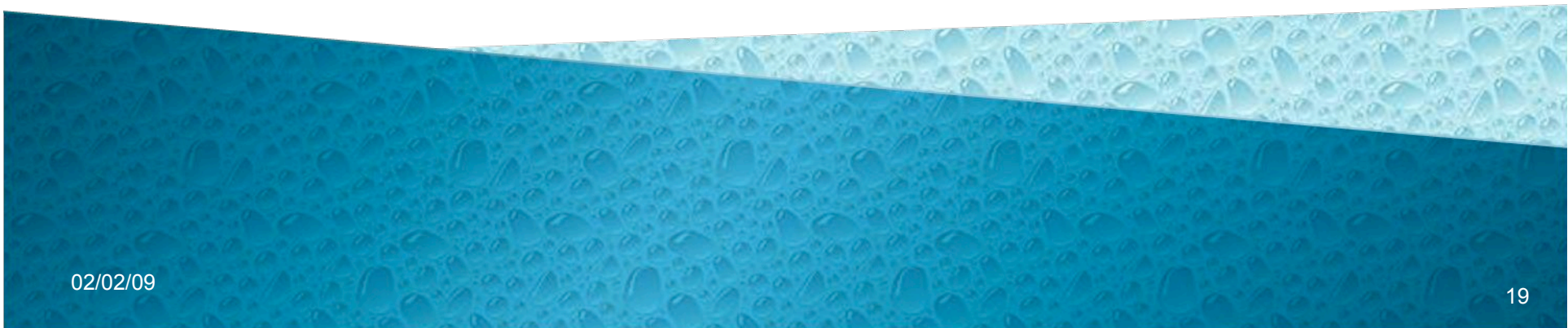
| Comparison Of Baseline vs. Optimum BOC Injection Period | Baseline Period Aver. 11/06-5/07 | BOC Optimum Injection Period Aver.-11/07-5/08 | % Increase (Decrease) Over Baseline | Notes |
|--|-------------------------------------|---|---|-----------------|
| Daily BTU's required to heat primary feed sludge to aver. AD temp. | 8,100,070 | 9,405,563 | 16% | Increase |
| Excess daily cu ft of biogas produced to Heat Primary Feed Sludge To Aver. AD Temp | 5,318 | 19,282 | 263% | Increase |
| NG-Therms used daily aver. | 151 | 75 | 101% | Decrease |
| NG-Therms/ M gallons of primary feed sludge | 5.42 | 2.34 | 132% | Decrease |
| Aver.-Nat Gas Cost/month | \$ 8,455.69 | \$ 2,953.76 | 186% | Decrease |
| Excess daily biogas BTU's produced | 2,659,168 | 11,569,450 | 335% | Increase |

Reduction Of Sludge Volumes

Comparison of Sludge Baseline Values & BOC Injection Period

| Comparison Of Baseline vs. Optimum BOC Injection Period | Baseline Period Aver. 03/07-7/07 | BOC Optimum Injection Period Aver.-3/08-7/08 | % Increase (Decrease) Over Baseline | Notes |
|--|----------------------------------|--|-------------------------------------|------------------|
| Influent Flow-MGD | 3.45 | 2.45 | -28.9% | Decreased |
| Primary Feed Gallons Per Gallon of Influent Flow | 0.0085 | 0.0128 | 33.4% | Increased |
| % Waste Haulage Gallons Vs Primary Feed Gallons | 12.2% | 9.1% | 25.2% | Decreased |
| Primary Feed Sludge (GPD) | 27,426 | 32,216 | 15% | Increased |
| Primary Feed Sludge % T.S. | 1.88% | 1.81% | 3.8% | Decreased |
| Primary Feed Sludge % T.V.S. | 85.65% | 85.21% | .5 % | Decreased |
| Sludge Haulage daily gallon aver | 3,166 | 2,713 | 14.3% | Decreased |
| Actual Sludge Haulage Volume reduction (Corrected for increased AD loading) | | | 29.3% | Decreased |

Reduction Of Secondary Aeration Energy



Reduction Of Secondary Aeration Energy

There is a reduction of energy consumption within the facility's aeration channels from the "carry-over-effect" of the BOC injection into the anaerobic digester (AD) as the sludge thickening supernatant is returned to the front end influent wastewater, thereby enhancing the transfer of dissolved oxygen in secondary aeration channels.

- This aeration energy savings provides an important secondary economic value to the BOC process optimization of the anaerobic digester (AD) application.
- The aeration energy savings offers the wastewater operator an additional energy conservation strategy within a volatile energy marketplace.
- Overall aerobic processes and BNR exhibit positive performance characteristics due to improvement of transfer of dissolved oxygen and management of optimum dissolved oxygen levels.

Reduction Of Secondary Aeration Energy

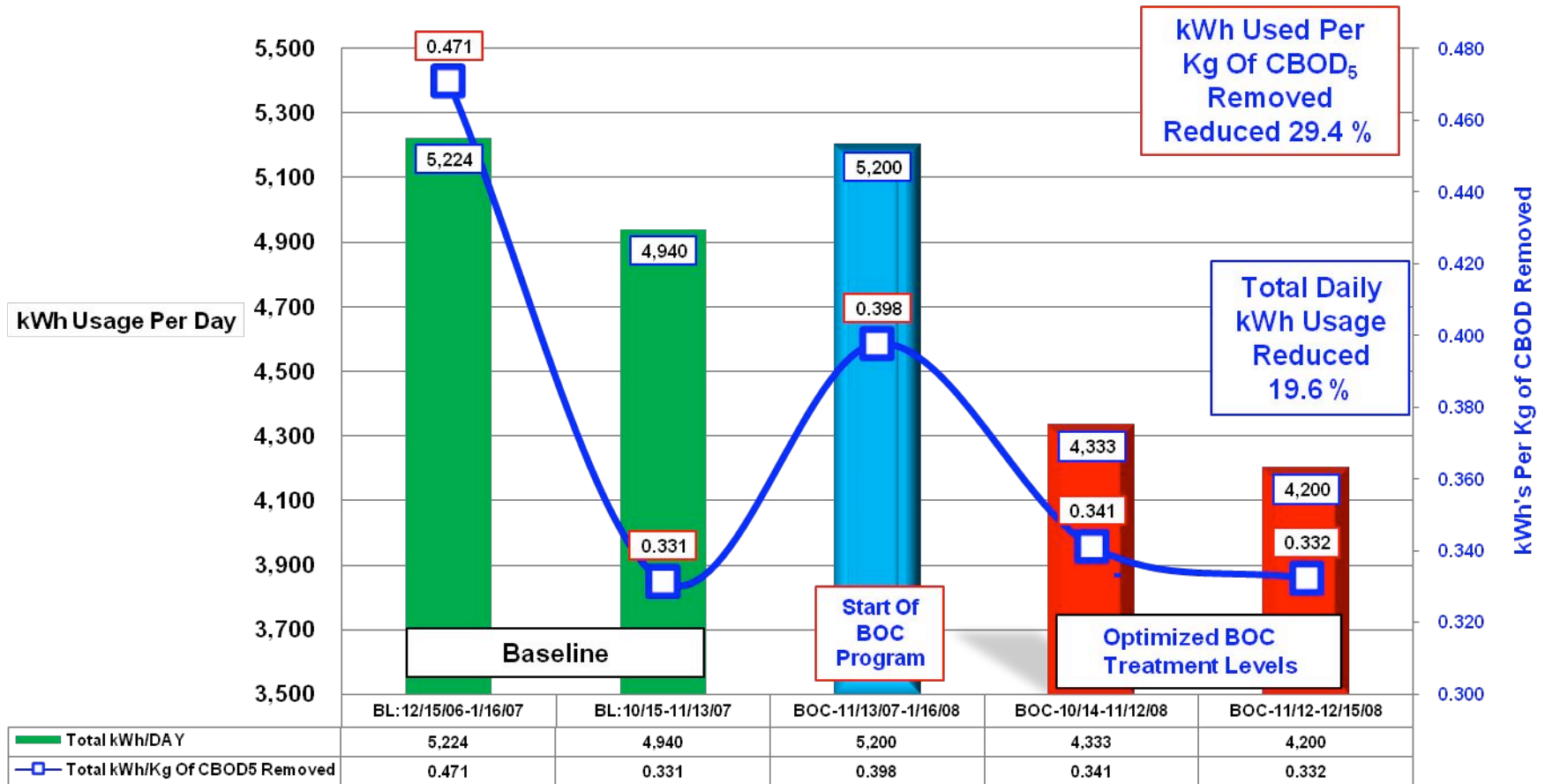
- **20.8% reduction in Measured Demand On-Peak 1 kW.**
- **24.5 % reduction in Measured Demand Off-Peak 1 kW.**
- **19.7% reduction in Measured Demand Off-Peak 2 kW.**
- **29.4% reduction in total kWh's per Kg of CBOD₅ removed.**
- **20% reduction in kWh's used per day.**

Reducing Measured Peak and Off Peak kWh Usage



Reduced kWh's Usage Per Day, per Kg

Reduced kWh's Used Per Kg , Which Results In Lower kWh's Per Day



Secondary Aeration Energy Savings Per Day & Annually

Based on the average prior baseline kWh usage of 5,224/day and the reduction of 1,000 kWh per day, daily and annual electrical savings are calculated as follows:

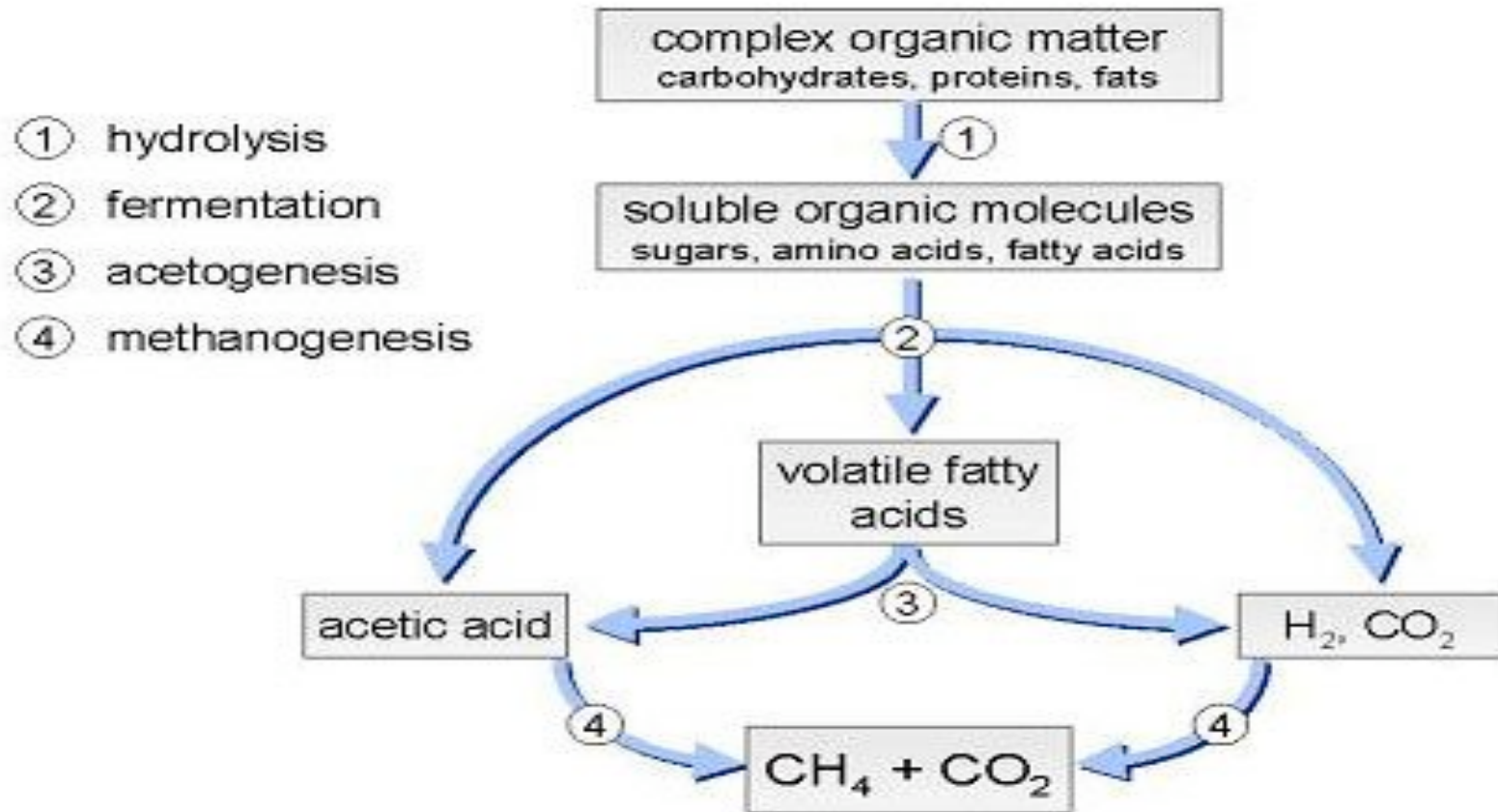
The average daily energy cost (kWh) during the early baseline period (12/15/06-1/16/07) was \$.099/kWh, during which 5,224 kWh's were used. The prior average daily energy cost per day was \$519.64.

During the BOC Optimization period the average daily energy cost rose to \$.1327/kWh, or the equivalent of \$693.22 per day

At a savings of 1,000 kWh daily, this translates to a savings of \$132.67 per day, and a savings of \$48,424.55 per year.

Anaerobic Digestion Optimization With BOC

The Anaerobic Digestion Sequence



Anaerobic Digestion Optimization with BOC

The bio-catalytic action of BOC on the various organic components of a sludge waste stream, including the lipids, indicates that there is an accelerated release of high nutrient values to indigenous microbiological populations within the bio-digester system.

This leads to a faster transition to the Methanogenesis phase, along with higher microbiological vigor, producing a more complete biological consumption of TS & TVS.

This study showed a correlation to biomethane yield improvements and TS & TVS consumption rates. This 1 year study demonstrates these trend lines as optimization is reached.

Distinct qualitative characteristics of sludge discharged from AD exhibited substantial odor reductions, which follows from a more complete consumption of TVS components.

Summary Of Results

Summary Of BOC Anaerobic Digestion Optimization

- **62% increased biogas production produced an annual savings of \$38,500 in NG purchases against the baseline period.**
- **Increased biomethane yields offer potential further annual NG savings of \$24,500 - \$31,000 through a reduction, or elimination, of NG usage in Building Boiler.**
- **29.3% reduction of sludge volumes offers projected savings annually of \$18,945.38.**
- **Reduction of secondary aeration energy usage on total kWh's used per Kg of CBOD₅ has been reduced by 29.4%, for a savings of \$132.67 per day, or a savings of \$48,424.55 per year.**



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